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(54) **Fluid-impermeable composite hose**

Flüssigkeitsundurchlässiger, mehrschichtiger Schlauch

Tuyau composite imperméable aux fluides

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US-A- 5 488 975

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Description

BACKGROUND OF THE INVENTION

Field of the Invention:

[0001] This invention relates to a fluid-impermeable composite hose, and more particularly, to one for transporting a fluid, such as any of various kinds of gases, gasoline or a refrigerant. This invention is particularly useful as a hose for transporting a refrigerant, such as flons or carbon dioxide.

Description of the Related Art:

[0002] As a hose for transporting a fluid, there is a demand for a fluid-impermeable hose which can, for example, transport any flon as a refrigerant without allowing it to leak out into the atmosphere and destroy the ozone layer, or realize a cooler system not necessitating any replenishment of a refrigerant, or a fuel hose not allowing any fuel vaporization. There is a particularly large demand for an improved hose for transporting e. g. carbon dioxide as a refrigerant, since this refrigerant gas easily permeates through the wall of a hose for a number of reasons including its high pressure, high temperature and low molecular weight.

[0003] It is effective to use a metallic foil to make a hose which is highly impermeable to a fluid and yet sufficiently flexible to resist any vibration satisfactorily. The foil has, however, the drawback of being broken very easily. Attempts have, therefore, been made to form a hose from a laminated sheet prepared by holding a metallic foil between a pair of resin films, or from such a laminated sheet and a thin elastic layer of e.g. rubber bonded thereto, so that the materials used with the foil may reduce or absorb the bending or expansive deformation of the hose which may cause the foil to be broken.

[0004] These attempts are effective for preventing the fatigue failure of the foil from being caused by its abnormal deformation, including wrinkling, as a result of the repeated bending or deformation of the hose, but there has not been proposed any hose including a metallic foil which is not broken by a tensile force when the wall of the hose is stretched.

[0005] A metallic foil forming a hose is not only broken when the hose is bent or deformed, but it is also broken easily when pulled, since it is hardly stretchable. If a hose formed from a laminated sheet comprising a metallic foil and resin films expands and has a wall portion stretched when holding a fluid having an elevated pressure, it is often the case that only the foil is broken, while the resin films remain unbroken because of their stretchability.

[0006] US-A-4 510 974 discloses a fluid conveying hose comprising an inner layer of plastic, an impermeable layer comprising a plastic film having an overlapping seam and having a surface which is integrally evaporated with a metal film, e.g. aluminium film, and an outer layer formed on the surface of the impermeable layer. The outer layer is constituted by a reinforcing layer and a seamless protective cover layer which is formed on the reinforcing layer. The impermeable layer is constructed as a single thin member and serves as a barrier to prevent the permeation of fluids from both inside and outside without affecting the flexibility of the hose. US-A-3 614 967 discloses a pipe coating comprising at least two preformed insulating members capable of surrounding a pipe to be coated in abutting relationship and a surrounding mat including a layer of heat softening resin, a layer of woven glass fabric, a second coating of said resin, a layer of conductive metal foil, a third layer of resin and an outer layer of water impervious plastic sheeting, said mat surrounding the insulating members and overlapping at adjacent edges. The adjacent edges of the mat are heat fused on the adjoining surfaces.

SUMMARY OF THE INVENTION

[0007] It is, therefore, an object of this invention to provide a fluid-impermeable hose including in its wall a metallic foil which is not damaged or broken even if the hose may be bent, deformed or stretched.

[0008] This object is essentially attained by a composite hose according to claim 1.

[0009] The above and other objects and advantages of this invention will become more apparent from the following description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Figure 1 is a partly cutaway perspective view showing a plurality of layers forming the wall of a fluid-impermeable composite hose according to a first preferred embodiment of this invention;
Figure 2A is a partly cutaway perspective view showing a plurality of components forming a laminated layer in the wall of the hose shown in Figure 1;
Figure 2B is a cross sectional view of the same laminated layer;
Figure 3 is a fragmentary longitudinal sectional view of the hose shown in Figure 1;
Figure 4 is a fragmentary transverse sectional view of a modified form of the hose shown in Figure 1; and
Figure 5 is a partly cutaway perspective view showing a plurality of layers forming the wall of a fluid-impermeable composite hose according to a second preferred embodiment of this invention.

DETAILED DESCRIPTION OF THE INVENTION

[0011] According to a first aspect of this invention,

there is provided a fluid-impermeable composite hose having a wall formed by a plurality of layers sequentially comprising an inner layer of rubber, a laminated layer, and an outer layer of rubber, wherein said laminated layer is of a laminated sheet comprising a metallic foil, a reinforcing material having stretch resistance and a resin film laid thereon. The stretch resistance of the reinforcing material protects the metallic foil from being broken by a tensile force bearing upon it in any direction when the hose has a wall portion expanded radially by a fluid having an elevated pressure, or stretched longitudinally by any unexpected tensile force acting upon it. The resin film protects the foil from any appreciable fatigue failure even if the hose may be bent or deformed. Thus, the hose can maintain a satisfactorily high level of flexibility and a high fluid impermeability for a long time as imparted to it by the metallic foil which it includes. The fluid impermeability means that the hose is impermeable to both a fluid which it transports, and water or any other fluid from any external source.

[0012] According to a second aspect of this invention, there is provided a hose in which the reinforcing material in the laminated sheet is a wire mesh, or a reinforcing fabric. A wire mesh, or reinforcing fabric is preferred as the reinforcing material in view of the properties and functions required of it as stated above.

[0013] According to a third aspect of this invention, there is provided a hose in which the metallic foil and reinforcing material in the laminated sheet are so bonded to each other as to form a unitary structure. This construction has the advantage that, even if the resin film may be stretched as a result of the radial expansion, or longitudinal stretching of the hose, the foil held by the reinforcing material is not pulled thereby, but is still more resistant to breaking.

[0014] According to a fourth aspect of this invention, there is provided a hose in which the laminated layer is formed by a helically wound, or longitudinally lapped tape of the laminated sheet. The helical winding, or longitudinal lapping of the tape greatly facilitates the formation of the laminated layer on the hose which is a cylindrical body. The helically wound, or longitudinally lapped tape preferably has its edge portions overlap each other to some extent or other to ensure the fluid tightness of the laminated layer.

[0015] According to a fifth aspect of this invention, there is provided a hose in which the tape has its edge portions overlapping each other and bonded to each other. The overlapping edge portions bonded to each other ensure the still higher fluid tightness of the laminated layer.

[0016] According to a sixth aspect of this invention, there is provided a hose including an elastic layer joined to the laminated layer. The metallic foil is still more resistant to fatigue failure, or breaking, since when the hose is bent or deformed, the foil is protected not only by the resin film, but also by the elastic layer which reduces or absorbs any force acting upon the foil when the hose is bent or deformed.

[0017] According to a seventh aspect of this invention, there is provided a hose in which the layers consist of (1), (2) and (4), or (1), (2), (3) and (4), as viewed in the order of their appearance radially outwardly across the wall:

(1) an inner layer of rubber;
(2) the laminated layer, or the laminated and elastic layers;
(3) a reinforcing layer; and
(4) an outer layer of rubber.

These combinations of layers are typical or preferred examples of the wall structure of the hose according to this invention.

[0018] The invention and the first to seventh aspects thereof will now be described in further detail.

[Fluid-Impermeable Composite Hose]

[0019] The-fluid-impermeable composite hose of this invention can be used for transporting various kinds of fluids, such as various kinds of gases, fuels and refrigerants (e.g. flons and carbon dioxide). It is particularly useful as a hose for transporting a fuel, or refrigerant of which the effects on the environment have to be strictly restricted.

[0020] The hose of this invention is not specifically limited in construction if it has a composite wall including a laminated layer which includes a metallic foil. Typical or preferred examples of its wall structure are, however, given by a wall including a laminated layer between an inner layer of rubber and an outer layer of rubber, a wall further including an elastic layer joined to the laminated layer and a wall further including a reinforcing layer between the laminated layer, or the laminated and elastic layers and the outer layer.

[0021] The inner layer may be of any rubber, but is preferably of any of butyl rubber (IIR), chlorinated butyl rubber (Cl-IIR), brominated butyl rubber (Br-IIR), acrylonitrile-butadiene rubber (NBR), chlorinated polyethylene rubber (CPE), ethylene-propylene-diene rubber (EPDM) and chloro-sulfonated polyethylene rubber (CSM). The outer layer also may be of any rubber, or resin, but is preferably of any of chloroprene rubber (CR), butyl rubber, chlorosulfonated polyethylene rubber and ethylene-propylene-diene rubber.

[0022] The reinforcing layer may be of any known structure and may, therefore, comprise, for example, a braided layer of wire, or reinforcing fiber, two spiral layers of reinforcing fiber wound spirally in opposite directions to each other, or two such spiral layers between which an intermediate layer of rubber is interposed.

[0023] Every two adjoining layers, such as the inner or outer layer and the laminated layer(or the laminated/elastic layers) may or may not be bonded to each other with an adhesive, or otherwise.

[Laminated Sheet]

[0024] The laminated layer is formed by a laminated sheet which comprises a metallic foil, a reinforcing material having stretch resistance and a resin film laid on one or both sides thereof. The resin film may be fused, or adhesively bonded to the foil, or reinforcing material.

[0025] The reinforcing material may be of any kind if it has a high stretch resistance, but is preferably a flexible material. A few examples of preferred materials are a wire mesh and a reinforcing fabric, such as canvas or nonwoven fabric formed from aramid, carbon, glass or other fibers of low stretchability, while a resin film of high strength can also be used.

[0026] The reinforcing material may be located either inwardly or outwardly of the foil, but is preferably located outwardly. The foil and reinforcing material are preferably bonded to each other for the reasons as stated before in connection with the hose according to the third aspect of this invention, though they may not necessarily have to be bonded to each other. The resin film may or may not be bonded to the foil, or reinforcing material.

[0027] The resin film may be of any resin, but is preferably of a thermoplastic resin, such as a polyamide (PA), polyethylene terephthalate (PET), or ethylene-vinyl alcohol copolymer resin. The resin film is not specifically limited in rigidity or thickness, but preferably has a flexural modulus of 1,000 to 300,000 kgf/cm2 and a thickness of 5 to 100 μm.

[Laminated Layer]

[0028] The laminated layer may be formed in any shape from the laminated sheet, but can advantageously be formed by a helically wound, or longitudinally lapped tape of the laminated sheet. The longitudinally lapped layer may be formed by placing a tape along the length of the inner layer which is tubular in shape, and lapping it around the inner layer. The helically wound, or longitudinally lapped tape preferably has its edge portions overlap each other to ensure the fluid tightness of the laminated layer, and more preferably has its overlapping edge portions bonded to each other by the fusion of the resin film, or with the aid of an adhesive.

[Elastic Layer]

[0029] The elastic layer protects the metallic foil still more effectively if it is joined to the laminated layer, as is obvious from the foregoing description of the hose according to the sixth aspect of this invention, though it may not be an essential component of the hose according to this invention. The elastic layer is preferably a layer of sponge, or a relatively thin layer of rubber, and is preferably bonded to the inner or outer side of the laminated layer, or more preferably to the outer side thereof, by the fusion of the resin film in the laminated layer, or with the aid of an adhesive.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] The invention will now be described more specifically by a few preferred embodiments thereof.

Preferred Embodiment 1:

[0031] Figure 1 shows a fluid-impermeable composite hose 6 having a composite wall formed by an inner layer 1 of IIR, a laminated layer 2, which is shown in detail in Figures 2A and 2B, an elastic layer 3 of IIR, a reinforcing layer 4 formed by braiding reinforcing fiber of an appropriate material and an outer layer 5 of EPDM, as viewed in the order of their appearance radially outwardly across the wall.

[0032] The laminated layer 2 is composed of a laminated sheet 11 prepared by bonding an aluminum foil 9 and a reinforcing canvas 10 together between an inner resin film 7 and an outer resin film 8 which are each a thin film of a thermoplastic resin known as PET, as shown in Figures 2A and 2B. The metallic foil 9 is bonded to the reinforcing material 10 by an adhesive not shown to form a unitary structure, and is so held thereby that no tensile force acting upon the laminated layer 2 may affect the foil 9. The foil 9 is shown as being located inwardly of the reinforcing material 10, but their positions can be reversed.

[0033] The laminated layer 2 may be formed by winding a tape of the laminated sheet 11 helically about the inner layer 1, as shown in Figure 3. The tape 11 has its edge portions overlapping each other to some extent or other, and bonded to each other with an adhesive to ensure the impermeability of the wall to a refrigerant, etc. to a still further extent.

[0034] A modified form of the laminated layer 2 is shown in Figure 4, and comprises a longitudinally lapped tape of the laminated sheet 11 surrounding the inner layer 1. The tape 11 preferably has its edge portions overlapping each other and bonded to each other with an adhesive.

Preferred Embodiment 2:

[0035] Figure 5 shows a hose 12 having a composite wall formed by an inner layer 1 of rubber, a laminated layer 2, a reinforcing layer 4 and an outer layer 5 of rubber, as viewed in the order of their appearance radially outwardly across the wall. It is of the same construction with the hose shown in Figure 1 from which the elastic layer 3 is excluded.

Modifications:

[0036] Possible modifications include a structure obtained by excluding the reinforcing layer 4 from the hose 6 shown in Figure 1, or the hose 12 shown in Figure 5.

Claims

1. A fluid-impermeable composite hose (6; 12) having a wall formed by a plurality of layers, **characterized in that** said wall sequentially comprises an inner layer of rubber (1), a laminated layer (2) and an outer layer of rubber (5), wherein said laminated layer (2) is of a laminated sheet (11) comprising a metallic foil (9), a reinforcing material (10) having stretch resistance and a resin film (7; 8) laid thereon.

2. The hose (6; 12) of claim 1, further comprising, between the laminated layer (2) and the outer layer of rubber (5), a reinforcing layer (4).

3. The hose (6; 12) of claim 1 or 2, further comprising, between the laminated layer (2) and the next layer (4 or 5), viewed radially outwardly, an elastic layer (3).

4. The hose (6; 12) of any one of claims 1 to 3, wherein the laminated sheet (11) comprises an inner resin film (7) and an outer resin film (8).

5. The hose (6; 12) of any one of preceding claims, wherein said hose (6; 12) is a hose for transporting a refrigerant.

6. The hose (6; 12) of any one of preceding claims, wherein said reinforcing material (10) is selected from among a wire mesh and a reinforcing fabric.

7. The hose (6; 12) of any one of preceding claims, wherein said foil (9) and said reinforcing material (10) are so bonded to each other as to form a unitary structure.

8. The hose (6; 12) of any one of preceding claims, wherein said resin film (7; 8) is of a resin selected from among polyamide, polyethylene terephthalate, and ethylene-vinyl alcohol copolymer resins.

9. The hose (6; 12) of any one of preceding claims, wherein said resin film (7; 8) has a thickness of 5 to 100 μm and a flexural modulus of 1,000 to 300,000 kgf/cm^2.

10. The hose (6; 12) of any one of preceding claims, wherein said laminated layer (2) is formed by a helically wound, or longitudinally lapped tape of said laminated sheet (11).

11. The hose (6; 12) of claim 10, wherein said tape has its edge portions overlapping each other and bonded to each other.

Patentansprüche

1. Fluidundurchlässiger Kompositschlauch oder fluidundurchlässiges Kompositrohr (6; 12) mit einer Wandung, die aus einer Mehrzahl von Schichten gebildet ist, **dadurch gekennzeichnet, daß** die Wandung übereinander angeordnet eine innere Gummischicht (1), eine Laminatschicht (2) und eine äußere Gummischicht (5) umfaßt, wobei die Laminatschicht (2) aus einem laminierten Flächengebilde (11) besteht, das eine Metallfolie (9), ein dehnungsfestes Verstärkungsmaterial (10) und einen Harzfilm (7; 8) aufweist, der darüber aufgetragen ist.

2. Schlauch oder Rohr (6; 12) nach Anspruch 1, außerdem zwischen Laminatschicht (2) und äußerer Gummischicht (5) eine Verstärkungsschicht (4) umfassend.

3. Schlauch oder Rohr (6; 12) nach einem der Ansprüche 1 oder 2, außerdem zwischen der Laminatschicht (2) und der nächsten Schicht (4 oder 5), radial von innen nach außen gesehen, eine elastische Schicht umfassend.

4. Schlauch oder Rohr (6; 12) nach einem der Ansprüche 1 bis 3, wobei das laminierte Flächengebilde (11) einen inneren Harzfilm (7) und einen äußeren Harzfilm (8) umfaßt.

5. Schlauch oder Rohr (6; 12) nach einem der vorangehenden Ansprüche, wobei der Schlauch oder das Rohr (6; 12) ein Schlauch oder ein Rohr zum Transport eines Kühlmittels ist.

6. Schlauch oder Rohr (6; 12) nach einem der vorangehenden Ansprüche, wobei das Verstärkungsmaterial (10) ausgewählt ist aus einem Drahtgewebe und einem Verstärkungsstoff.

7. Schlauch oder Rohr (6; 12) nach einem der vorangehenden Ansprüche, wobei die Folie (9) und das Verstärkungsmaterial (10) so miteinander verbunden sind, daß sie eine einheitliche Struktur bilden.

8. Schlauch oder Rohr (6; 12) nach einem der vorangehenden Ansprüche, wobei der Harzfilm (7; 8) aus einem Harz besteht, ausgewählt aus Polyamid-, Polyethylenterephthalat- und Ethylenvinylalkohol-Copolymerharzen.

9. Schlauch oder Rohr (6; 12) nach einem der vorangehenden Ansprüche, wobei der Harzfilm (7; 8) eine Dicke von 5 bis 100 μm und einen Biegemodul von 1000 bis 300000 kgf/cm^2 aufweist.

10. Schlauch oder Rohr (6; 12) nach einem der voran-

gehenden Ansprüche, wobei die Laminatschicht (2) aus einem in Helixform gewundenen oder in Längsrichtung überlappenden Band aus dem laminierten Flächengebilde (11) gebildet ist.

11. Schlauch oder Rohr (6; 12) nach Anspruch 10, wobei die Randbereiche des Bandes sich überlappen und miteinander verklebt sind.

Revendications

1. Tuyau composite imperméable aux fluides (6 ;12) ayant une paroi formée à partir d'une pluralité de couches, **caractérisé en ce que** ladite paroi comprend séquentiellement une couche interne de caoutchouc (1), une couche stratifiée (2) et une couche externe de caoutchouc (5), dans lequel la couche stratifiée (2) est réalisée à partir d'une strate (11) comprenant une feuille métallique (9), un matériau de renforcement (10) possédant une résistance à l'extension et un film en résine (7, 8) posé sur celui-ci.

2. Tuyau (6 ; 12) selon la revendication 1, comprenant en outre, entre la couche stratifiée (2) et la couche externe de caoutchouc (5), une couche de renforcement (4).

3. Tuyau (6 ; 12) selon la revendication 1 ou la revendication 2, comprenant en outre, entre la couche stratifiée (2) et la couche suivante (4 ou 5), vue de manière radiale vers l'extérieur, une couche flexible (3).

4. Tuyau (6 ; 12) selon l'une quelconque des revendications 1 à 3, dans lequel la strate (11) comprend un film interne en résine (7) et un film externe en résine (8).

5. Tuyau (6 ; 12) selon l'une quelconque des revendications précédentes, dans lequel ledit tuyau (6, 12) est un tuyau destiné à transporter un réfrigérant.

6. Tuyau (6 ; 12) selon l'une quelconque des revendications précédentes, dans lequel ledit matériau de renforcement (10) est choisi parmi un treillis métallique et un tissu de renfort.

7. Tuyau (6 ; 12) selon l'une quelconque des revendications précédentes, dans lequel ladite feuille (9) et ledit matériau de renforcement (10) sont liés entre eux de façon à former une structure unitaire.

8. Tuyau (6 ; 12) selon l'une quelconque des revendications précédentes, dans lequel le film en résine (7, 8) est réalisé à partir d'une résine sélectionnée parmi les résines de polyamide, de polyéthylène téréphtalate et de copolymère d'alcool d'éthylène de vinyle.

9. Tuyau (6 ; 12) selon l'une quelconque des revendications précédentes, dans lequel le film en résine (7 ; 8) a une épaisseur entre 5 et 100 µm et un module de flexion entre 1000 et 300 000 N/cm^2.

10. Tuyau (6 ; 12) selon l'une quelconque des revendications précédentes, dans lequel ladite couche stratifiée (2) est formée par une bande hélicoïdale ou une bande par recouvrement de manière longitudinale de ladite strate (11).

11. Tuyau (6 ; 12) selon la revendication 10, dans lequel ladite bande a ses parties d'extrémités superposées l'une sur l'autre et collées l'une à l'autre.

FIG.1

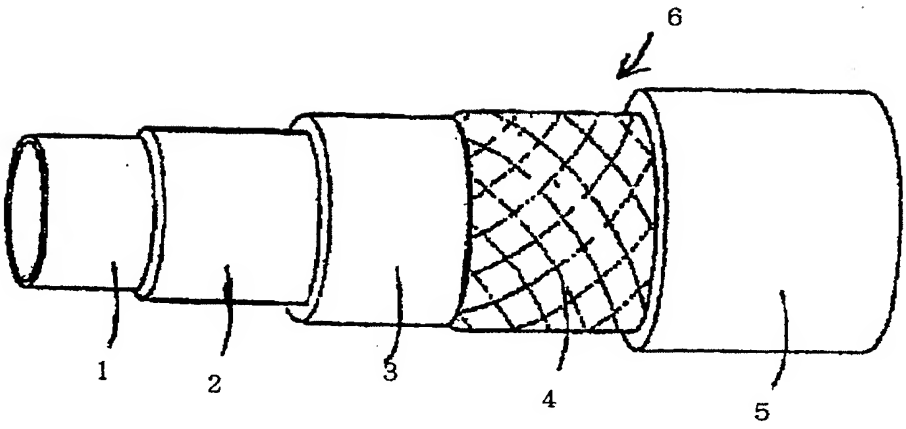

FIG.2A

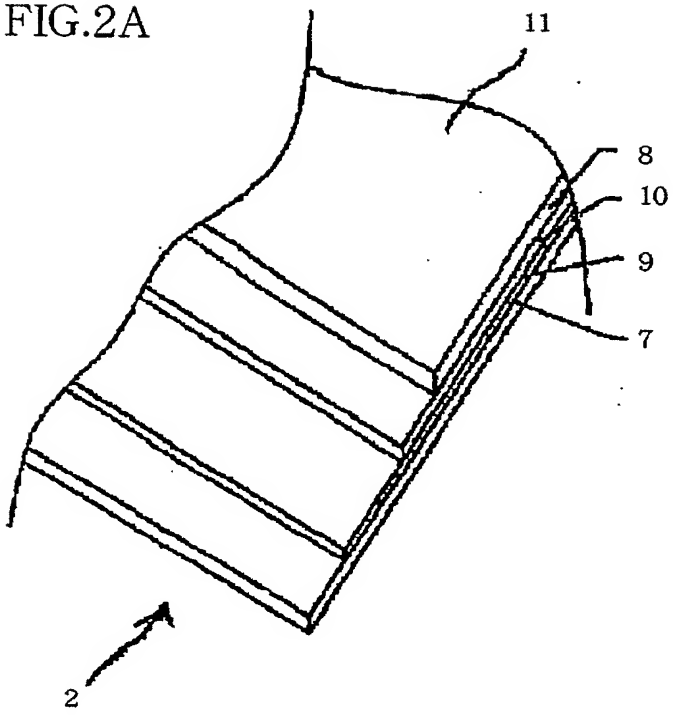

FIG.2B

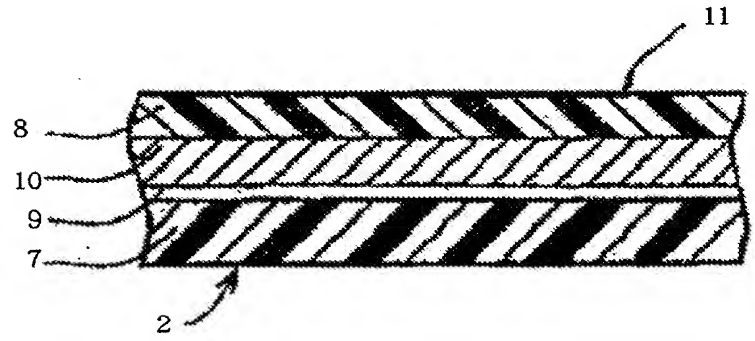

FIG.3

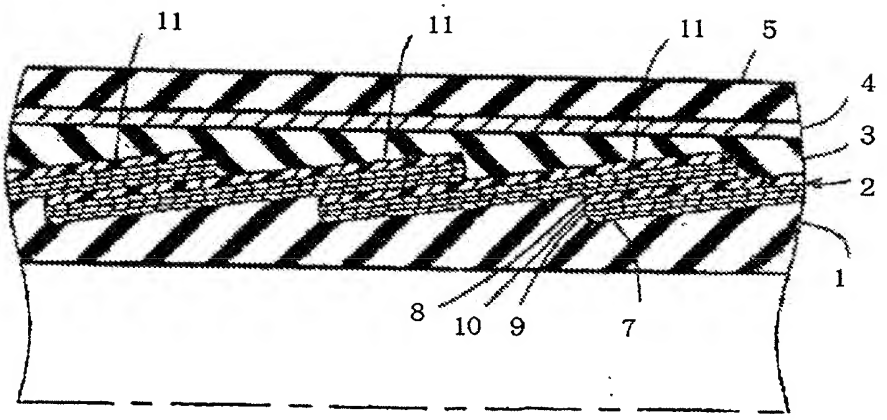

FIG.4

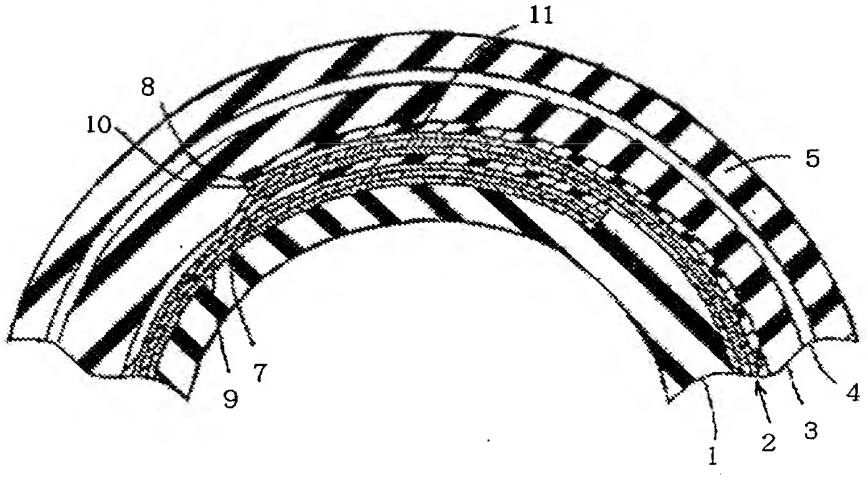

FIG.5